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Measuring the sense of the Dzyaloshinskii–Moriya interaction

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The spin-orbit Dzyaloshinskii–Moriya (DM) interaction EDM=D•[s1×s2] can induce small canting of neighboring magnetic moments s1 and s2. It is also very important for multiferroics and helimagnetic MnSi-type crystals with the spiral or Skyrmionic structures. The sense of the DM vector D has been experimentally determined for the first time in canted antiferromagnetic $FeBO_3$ crystal [1]. The technique of interference between magnetic and resonant channels in synchrotron x-ray scattering was exploited. The phase of antiferromagnetic ordering (and scattering) was fixed by external magnetic field and the phase of resonant scattering was calculated with FDMNES program. Similar experiments have been also performed for $MnCO_3$ and $CoCO_3$ crystals. For Fe_2O_3 hematite crystal, the technique of interference between magnetic and multiple diffraction channels has been used. The experimental measurements are supported by ab initio calculations of the DM interaction. The first-principles calculations have been performed with Local Density Approximation incorporating the on-site Coulomb interaction U and the Spin-Orbit coupling (LDA+U+SO) [2,3]. It was found how DM interaction depends on displacements of oxygen atoms. These experimental and theoretical approaches open up new possibilities for exploring, modeling and exploiting novel magnetic and multiferroic materials. VED and ENO are grateful to the RFBR research project No. 13-02-00760 and to the project of Presidium of Russian Academy of Sciences No. 24. The work of VVM is supported by the grant program of President of Russian Federation MK-5565.2013.2, the contracts of the Ministry of education and science of Russia N 14.A18.21.0076 and 14.A18.21.0889. MIK acknowledges a financial support by FOM (The Netherlands).

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